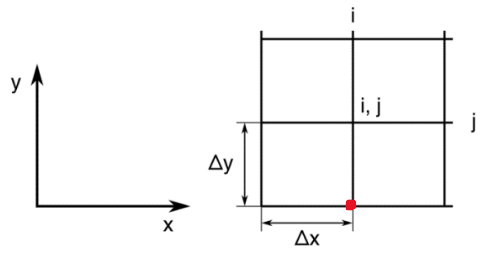
1. What are the derivatives in finite differences of the velocity point on the 2D grid?



$$\frac{\partial v_x}{\partial x} = \frac{v_{x,i+1,j} - v_{x,i,j}}{\Delta x}$$

$$\frac{\partial v_y}{\partial y} = \frac{v_{y,i,j+1} - v_{y,i,j}}{\Delta y}$$

2. Consider flow between two flat plates. Find the friction factor using the von-Karman-Pohlhausen velocity equation and the wall sheer stress at y=H.

$$v_x = U\left[\frac{3}{2}\left(\frac{y}{\delta(x)}\right) - \frac{1}{2}\left(\frac{y}{\delta(x)}\right)^3\right]$$

$$\tau_w = \mu \left.\frac{\partial v_x}{\partial y}\right|_{y=H}$$

$$\mu U\left[\frac{3}{2\delta(x)} - \frac{3}{2}\frac{y^2}{\delta(x)^3}\right]\Big|_{y=H} = \mu U\left[\frac{3}{2\delta(x)} - \frac{3}{2}\frac{H^2}{\delta(x)^3}\right]$$

$$f = \frac{2\tau_w}{\rho U^2} = \frac{2\mu}{\rho U^2}\left[\frac{3}{2\delta(x)} - \frac{3}{2}\frac{H^2}{\delta(x)^3}\right] = \boxed{\frac{3\mu}{\rho U \delta(x)}\left[1 - \frac{H^2}{\delta(x)^2}\right]}$$